

# **Unnamed Tributary, Chickahominy River: Benthic TMDL Development**

***2nd Public Meeting  
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# Project Team



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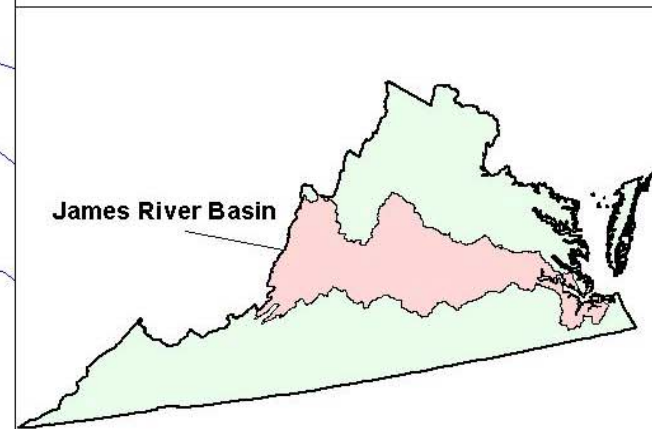
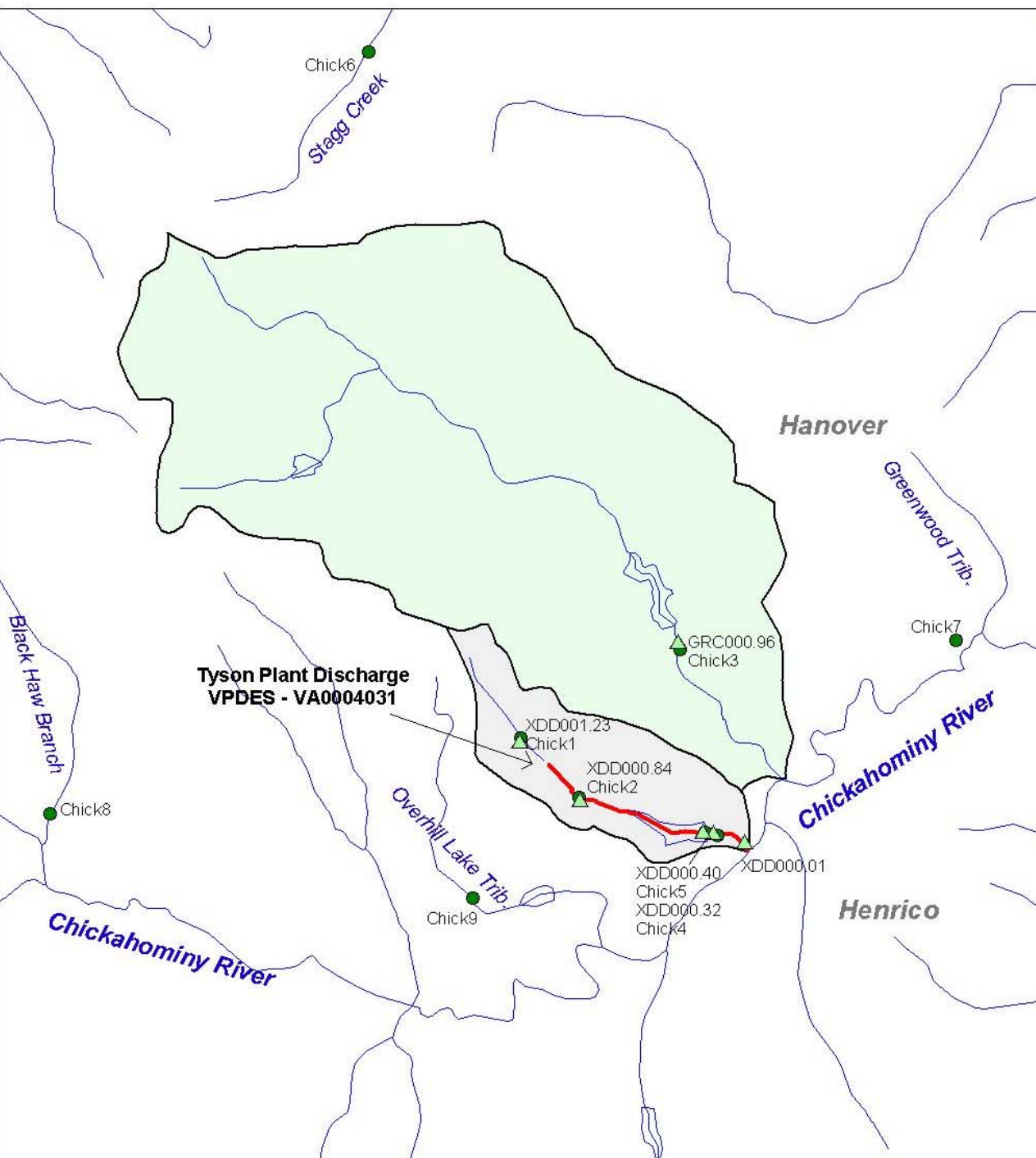


## Unnamed Tributary, Chickahominy: Location and Monitoring Stations

### Legend:

- △ VADEQ Monitoring Stations
- GMU Monitoring Stations
- 2002 303(d) Impaired Segment
- Rivers & Streams (NHD)
- UT Chickahominy Watershed
- Grassy Swamp Creek Watershed

0 1 Miles



# Benthic TMDL Development

Problem: Impaired streams do not support a healthy benthic macroinvertebrate community.

## Questions:

- What factors are causing the problem?
- For each stressor, what level of improvement is needed? Virginia Water Quality Standards do not contain numeric criteria for sedimentation, nutrients\*, and other stressors.

\* Chickahominy watershed effluent standard for total phosphorus: 0.1 mg/L

# Bioassessment Index Comparison

Station ID	Location	Virginia Stream Condition Index – Avg. Score
<i>UT Chickahominy Watershed</i>		
XDD001.23 (DEQ) Chick1 (GMU)	Upstream of Tyson discharge, downstream of headwaters impoundment	25
XDD000.84 (DEQ) Chick2 (GMU)	Below Tyson discharge	29
XDD000.32 (DEQ) Chick4 (GMU)	Below farm pond	22
Overall Avg.		25

Virginia Stream Condition Index (VaSCI):  
Impairment threshold score = 60



# Stressor Identification Analyses

- Candidate Causes:
  - Sedimentation
  - Degraded water quality (e.g., low DO, nutrients, ammonia, etc.)
  - Toxic pollutants
  - Habitat impacts (riparian zone)
- Identified stressors need to be reduced to allow for improvement in the benthic community
- Data Analyses
  - Ambient Water Quality Data: Temperature, DO, BOD, sedimentation (TSS), nutrients, etc.
  - DEQ storm sampling data
  - RBP habitat data
  - 24-hour dissolved oxygen data
  - GMU water quality and biomonitoring data
  - EPA toxicity tests: Measured survival/growth/reproduction of test organisms



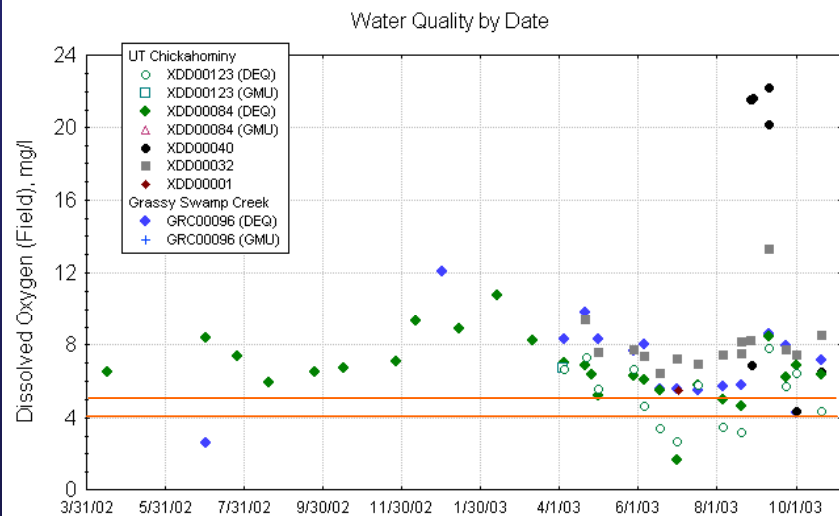
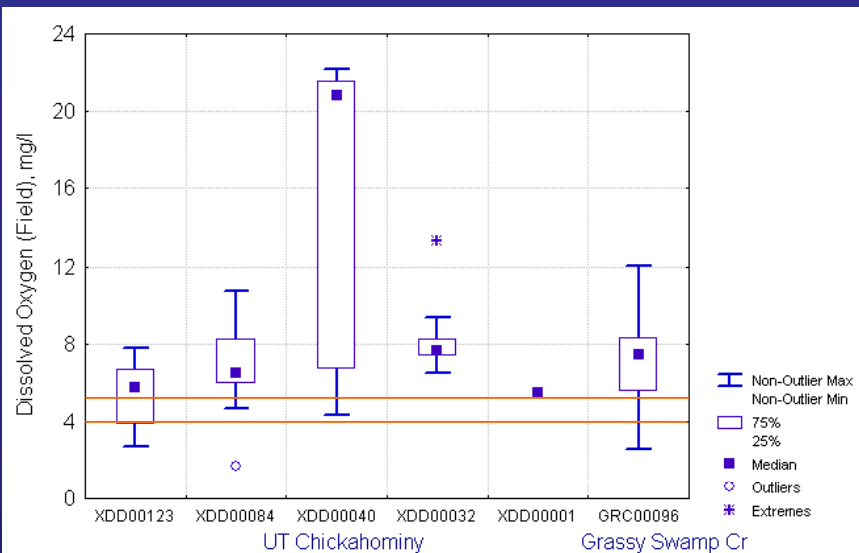


# Site Visit Pictures (April 2003)



# Dissolved Oxygen Analysis

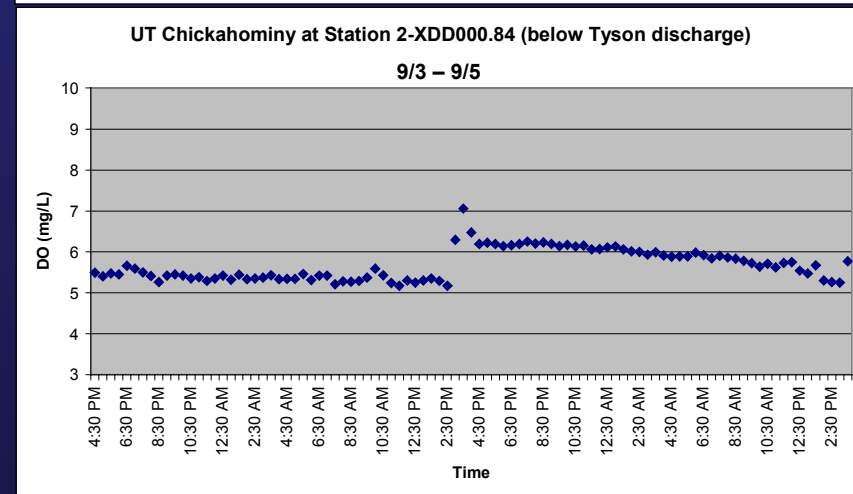
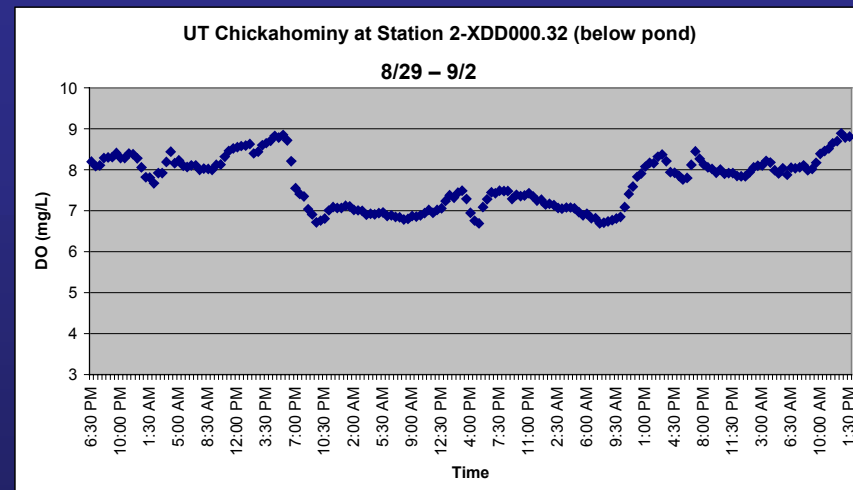
## AWQM Data Comparison



Virginia's DO Standards  
(Class III Nontidal Waters):

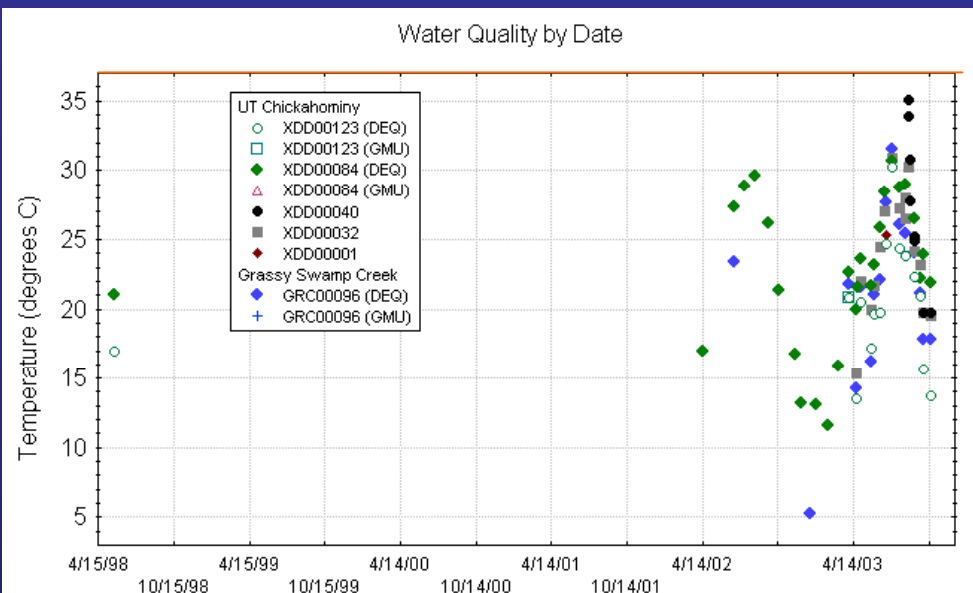
- 5.0 mg/L daily average
- 4.0 mg/L minimum

## 2003 Diurnal DO study





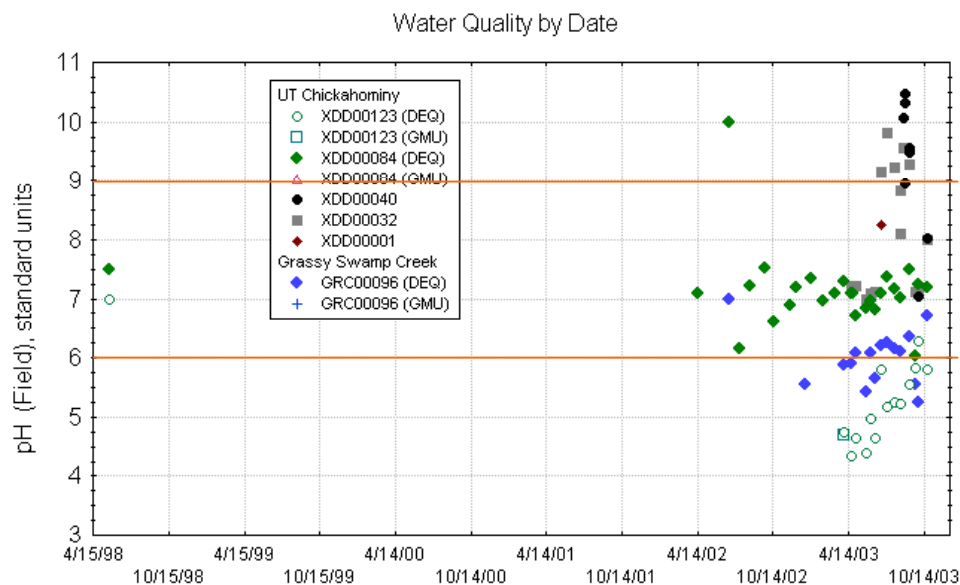
# Temperature and pH Analysis



## Virginia's Temperature and pH Standards

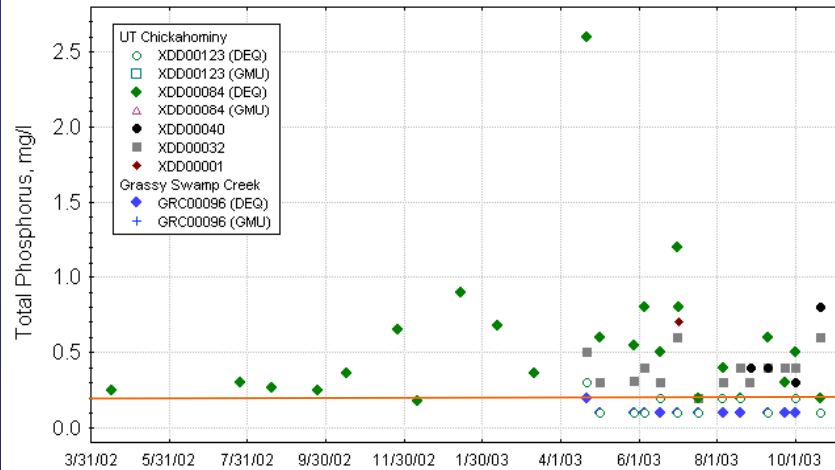
(Class III Nontidal Waters):

- 32 degrees Celsius – Maximum Temperature
- pH between 6.0 and 9.0

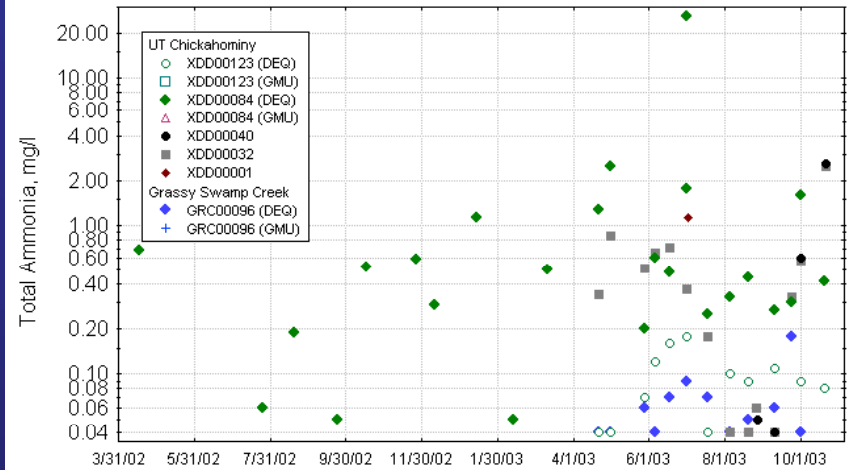


# Nutrient Analysis

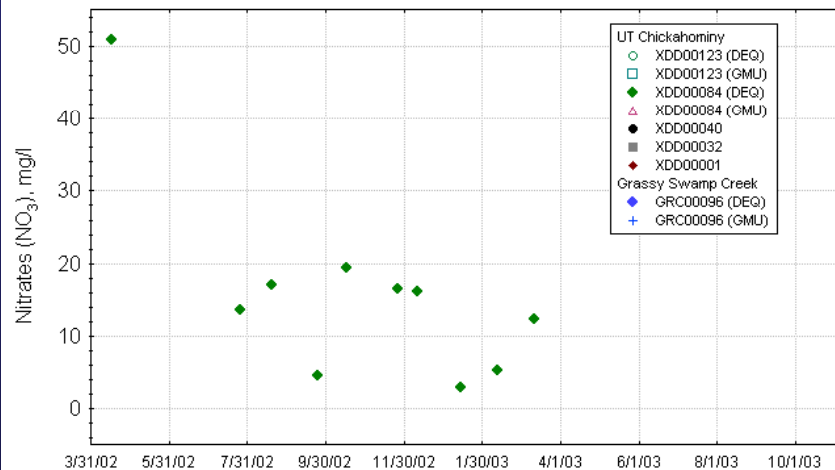
Water Quality by Date



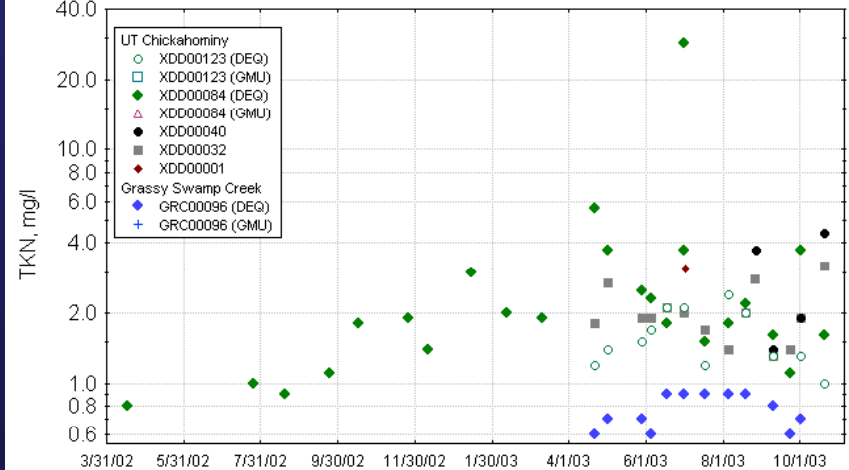
Water Quality by Date



Water Quality by Date

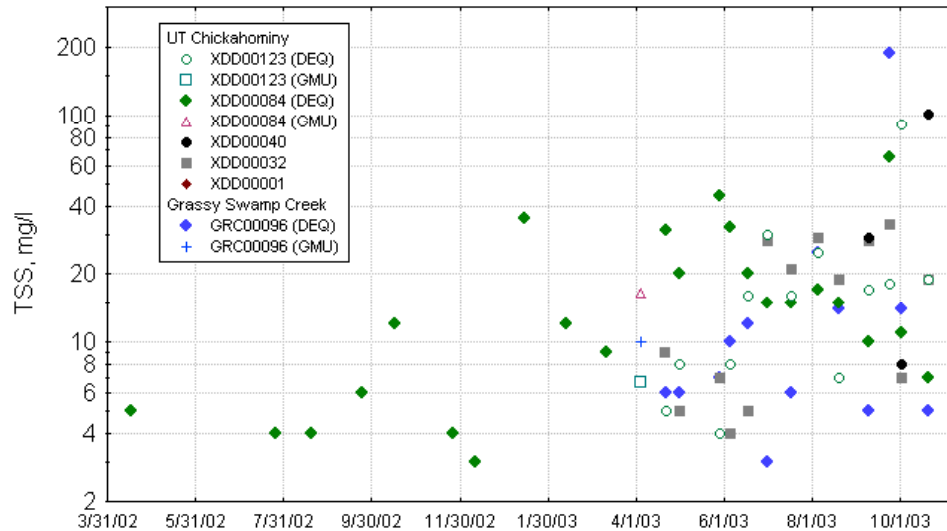


Water Quality by Date



# Sedimentation Analysis

Water Quality by Date



## RBP Habitat Data

Station	Data Period	Total Habitat	Bank Condition	Bank Vegetative Protection	Embed-dedness/Pool Substrate
XDD001.23	11/94 - 5/98	106	12	10	7
XDD000.84	11/94 - 5/98	94	7	6	6
XDD000.32	7/02 - 9/02	126	12	14	12
GRC000.96	7/02 - 9/02	111	10	10	7

Station	Date	Instream Cover	Riparian Vegetation Width	Sediment Deposition
XDD001.23	11/94 - 5/98	8	12	17
XDD000.84	11/94 - 5/98	5	10	10
XDD000.32	7/02 - 9/02	13	20	11
GRC000.96	7/02 - 9/02	12	20	8





# Point Source Information

- Tyson Foods – VPDES #VA0004031. Only point source discharge in the watershed.
- Discharges to UT Chickahominy <1 mile upstream of DEQ Station XDD000.84
- Data Period: 4/10/99 – 6/10/03  
Exceedances for TSS and Residual Chlorine.
- Ammonia exceedance recorded in 7/03
- Concentration limits for Total Phosphorus are greater than the DEQ 305(b) assessment criteria (0.2 mg/L)

Parameter	Quantity Limit	Concentration Limit
pH	Concentration: 6.0 – 9.0 std. units	N/A
BOD5	28.4 kg/day (monthly avg)	6 mg/L (monthly avg) 8 mg/L (daily max)
TSS	23.7 kg/day (monthly avg)	5 mg/L (monthly avg) 7.5 (daily max)
Fecal Coliform	N/A	200 cfu/100mL (monthly avg)
DO	N/A	5 mg/L (daily min)
Total Phosphorus	1.4 kg/day (monthly avg) 2.4 (daily max)	0.3 mg/L (monthly avg) 0.5 mg/L (daily max)
Ammonia	9.5 kg/day (monthly avg)	2 mg/L (monthly avg)
Settleable Solids	N/A	0.1 ml/L (monthly avg)
Residual Chlorine, Inst. Max	N/A	7.97 ppb (monthly avg) 16.09 ppb (daily max)
Oil & Grease	47.3 kg/day (monthly avg) 71 kg/day (daily max)	10 mg/L (monthly avg) 15 mg/L (daily max)

# UT Chickahominy – Watershed/Stream Observations

- Headwaters is very tannic. There is an impoundment located just above DEQ station XDD001.23, which impacts conditions at this site. Streamflow is minimal at this location and the riparian zone is disturbed.
- Large waterfowl population at the Tyson “Freshwater Pond”. Excess nutrient contributions to the stream.
- Minimal riparian vegetation along the stream corridor, primarily downstream of Tyson property.
- Tyson discharge dominates streamflow (>90%). Excess inputs of nitrogen and phosphorus to the stream.
- The farm pond located just upstream of Station XDD000.32 is hypereutrophic. High pH levels were noted in the pond and at Station XDD000.32
- Taxa data indicate a predominance of aquatic earthworms and leeches at Stations XDD000.84 and XDD000.32.

# UT Chickahominy – Stressor Conclusions

- Eutrophication of the “farm pond” has caused algal blooms and high pH conditions downstream. High pH levels are known to cause the loss of “intolerant” benthic organisms.
- Eutrophication is caused by excessive nutrient inputs from point and nonpoint sources in the watershed.
- Habitat quality is poor in localized areas. Riparian vegetation is minimal in some stream sections.
- EPA toxicity tests indicate possible toxicity problems (Fall 2003 samples from UT Chickahominy).
- **Develop TMDL for phosphorus (primary stressor)**



# TMDL Endpoint / Technical Approach

- TMDL endpoint for phosphorus was developed based on a eutrophication study of southeastern lakes and reservoirs (Reckhow 1988).
- Developed a simple eutrophication model for the “farm pond” based on the calculations in Reckhow 1988. Chlorophyll *a* concentration of 20 ug/L was chosen to represent the onset of eutrophication.
- Phosphorus reductions were based on the phosphorus load (for the pond) that meets this Chlorophyll *a* target.
- Model predictions:
  - Existing phosphorus load: 1,332 lbs/year
  - Target (TMDL) load: 434 lbs/year (67 % reduction)
- Phosphorus load estimates:
  - Watershed loads (land-based) were estimated using the GWLF model
  - Canada geese and gull contributions were calculated. Assumed 20 geese and 70 gulls were present in the watershed year-round.
  - Point source load calculated based on Tyson design flow (1.4 MGD) and monthly average concentration (0.3 mg/L phosphorus)

## Watershed Model - GWLF

- GWLF (Generalized Watershed Loading Functions) model was used to estimate phosphorus loads contributed by land uses in the watershed.
- Model attributes
  - Continuous simulation model
  - Models surface runoff using the Soil Conservation Service curve numbers
  - Based on the Universal Soil Loss Equation (USLE)

# Phosphorus TMDL & Allocations

## Existing

Source Category	Phosphorus Load (lbs/year)	% Contribution
Pasture/Hay	3.09	0.2%
Cropland	6.17	0.5%
Transitional	9.26	0.7%
Water	0	0%
Forest	0.44	0%
Urban	12.57	0.9%
Groundwater	9.04	0.7%
Point Source	1,279.21	96.0%
Wildlife	12.24	0.9%

Existing Load  
(lbs/year)

1,332.02

## Allocation

Source Category	Phosphorus Load (lbs/year)	% reduction
Pasture/Hay	0.99	68%
Cropland	1.98	68%
Transitional	2.96	68%
Water	0	0
Forest	0.44	0
Urban	4.02	68%
Groundwater	9.04	0
Point Sources	409.35	68%
Wildlife	3.92	68%

Overall % Reduction

67.5%

TMDL Load  
(lbs/year)

432.69

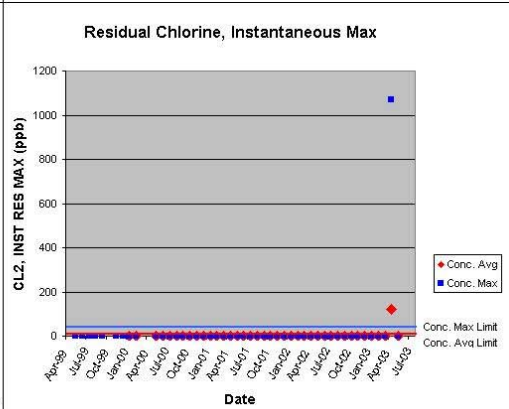
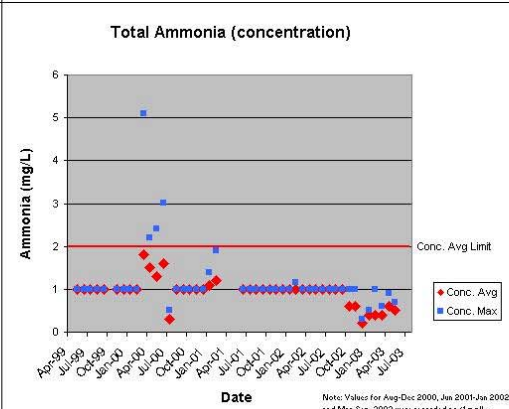
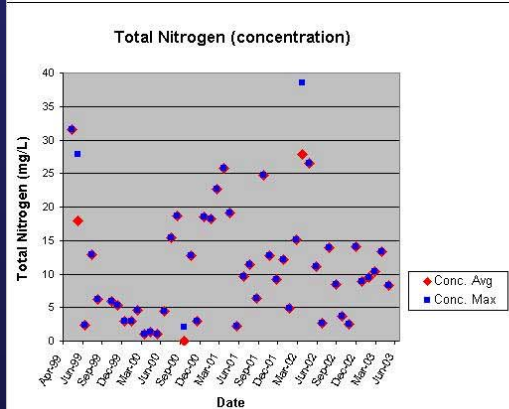
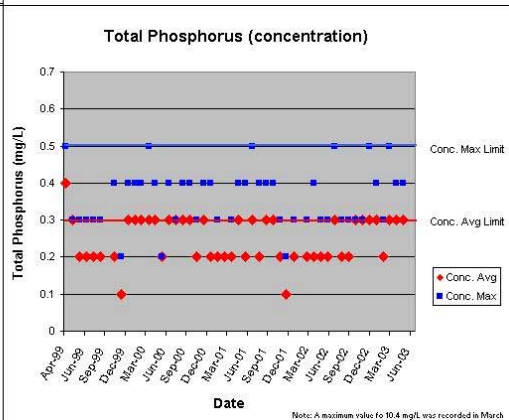
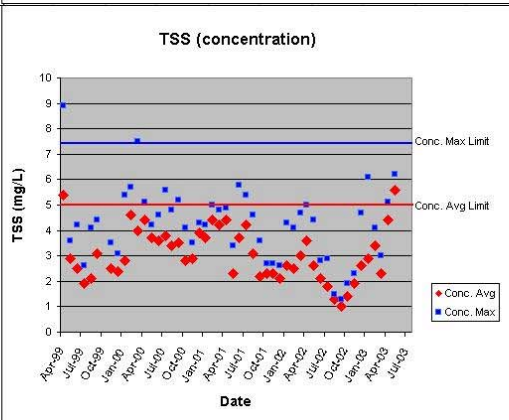
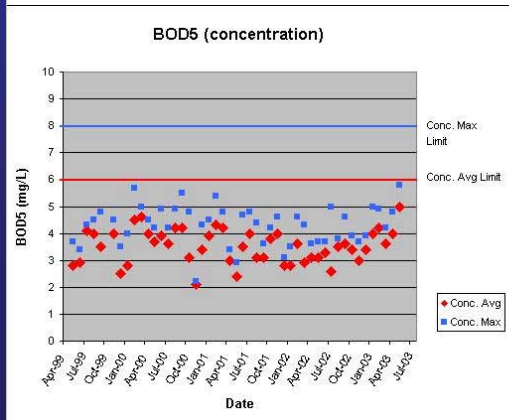
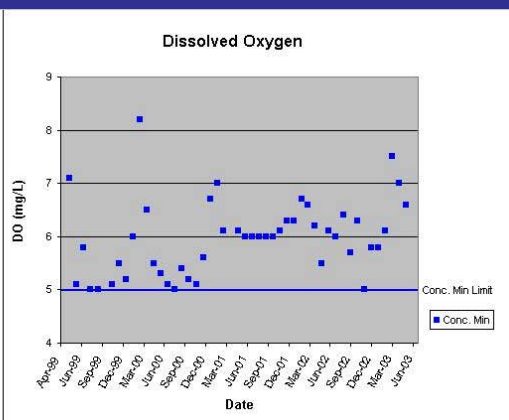
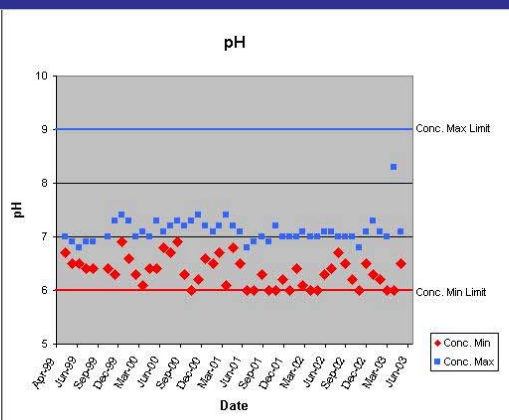
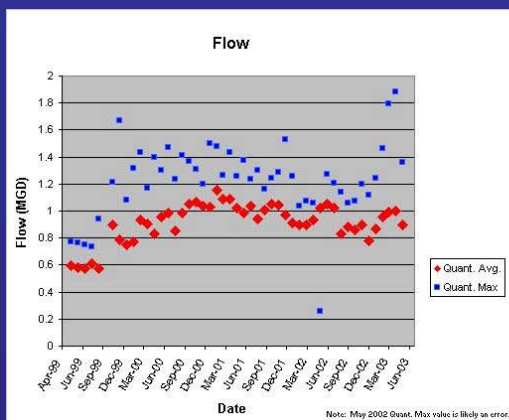


## Questions / Comments ?



# Discharge Monitoring Data (VA0004031)

(Data Period 4/10/99 – 6/10/03)



## Stressor Conclusions

- **Excessive sedimentation** is considered the primary stressor affecting the benthic community in Smith Creek.
- Low pH values observed in Mountain Run and Fridley Run.
- DO data indicate that DO conditions are adequate to support aquatic life.

# Bioassessment Index Comparison

Station ID	Stream	Sample Date	Virginia Stream Condition Index Score
UT Chickahominy Watershed			
XDD001.23	Upstream of Tyson discharge, downstream of headwaters impoundment	11/22/94	17
		5/1/95	25
		5/6/96	23
		10/23/96	20
		5/19/97	32
		11/12/97	31
		5/24/98	17
		Average	25
XDD000.84	Below Tyson discharge	11/22/94	9
		5/1/95	28
		5/6/96	32
		10/23/96	33
		5/19/97	31
		11/12/97	36
		5/24/98	31
		4/16/02	33
		9/24/02	29
		Average	29
XDD000.32	Below farm pond	7/1/02	21
		9/23/02	17
		Average	19
Potential Reference Stream			
GRC000.96	Grassy Swamp Creek, below impoundment	7/1/02	47
		9/24/02	32
		Average	40